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PAPERMAKING MATERIALS

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PAPERMAKING MATERIALS

Introduction.

The earliest paper was probably prepared from the papyrus plant (*Cyperus papyrus*). This is an aquatic plant common in many warm countries and especially in Egypt. From the layer between the flesh and thick bark of this reed or flag, strips or ribbons of different lengths were obtained, which were bleached in the sun and then spread upon a table and covered crosswise by other strips, moistened with water and pressed, thus causing adhesion of the strips by means of the vegetable mucilage naturally present in the bark (Davis). The oldest example of papyri known appears to be of the eighteenth dynasty of Egypt, or about 1700 B.C.

Papyri was followed by cotton and linen papers, and very much later, by straw and by chemical and mechanical wood pulp.

Though the threatened shortage of pulp wood has created renewed interest in other fibrous materials which may be used in the manufacture of paper, this interest is by no means confined to the present time. As early as 1765 Jacob Christian Schaeffer of Regensburg, Germany, published a work upon the different plants which he could transform into paper without the use of rags and gave specimens of papers prepared from poplar down, tree moss, hop tendrils, bark of grape vine, hemp, mulberry, aloe leaves, stinging nettle, bull-rush, cabbage stalks, water moss, turf, leaves of the lily of the valley, mallow, orache, Indian corn, genista, potato skins, etc., etc.

The next important historical document is probably that of Knoop, who printed part of his work on paper made entirely from straw. The paper is strong and tough, but of a light brown color, similar to straw wrapping paper, on which, however, even after one hundred years, the printed matter can easily be read. Since then, a very large number of fibrous materials have been tested for papermaking qualities. Davis in his "Manufacture of Paper," published in 1886, devotes 12 pages to a list of such materials. The wide variety will become evident from an examination of the list of plants which follows.

Classification of Papermaking Materials.

Clark [Paper xxiii, No. 25, 12 (Feb. 20, 1919)] has proposed the following classification of vegetable fibers used in papermaking:

A—Seed fibers, or seed hairs: growing from the seeds or seed-capsules of certain plants.

Cotton (Gossypium)

Bombax wool (East Indies) (Bombaceæ family)

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B—Stem or Bast fibers: growing in the bast of certain dicotyledonous plants.
Flax or Linen (Linum usitatissimum)
Common hemp (Cannabis sativa)
Jute or Calcutta hemp (Corchorus capsularis and clitoris)
Sunn hemp (Crotolaria juncea)
Manila hemp (Musa textilis)
Esparto (Stipa tenacissima)
Straw
Barley
Oat
Wheat
Rye
Nettle fibers.
Common nettle (Urtica dioica)
China grass (Bœhmeria nivea)
Ramie (Bœhmeria tenacissima)

C—Leaf fibers: occurring in the leaves of certain monocotyledonous plants.
New Zealand hemp or flax (Phormium tenax)
Manila hemp (Musa textilis)
Sisal or Domingo hemp (Agave rigida)
Mauritius hemp or Aloe fiber (Fourcroya foetida)
Maguey hemp or Pita fiber (Agave americana)
Pineapple fiber (Ananas sativa)
Vegetable wool from green cones of Pine and Fir

D—Fruit fibers: the only member of value is the cocoanut fiber (Cocos nucifera).

E—Wood fibers: obtained by chemical treatment of the wood from the stem or trunk of various trees.
Coniferous or Resinous trees
Cypress, bald
Hemlock
Spruce
Pine
Cedar
Fir
Broad-leaf or Non-resinous trees
Tulip
Gum
Mulberry
Birch
Beech
Poplar

The late Mr. Surface adopted the following classification in preparing a list of papermaking materials, which is said to have

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its foundation in the classification of Useful Plant Fibers as given by C. R. Dodge.

1 Textile papers—Wastes of industries, in which fiber is the chief product.
   (*a*) Spinning fibers in raw state; waste; seconds; tow; jute; butts; rope.
   (*b*) Spinning fibers after they have had a preliminary treatment or have already served a textile purpose; as rags.
2 Bast papers.
   Basts not used for textiles; as paper mulberry, adansonia.
3 Palm papers.
   Fibrous materials from palms or similar monocotyledons; as palmetto, yucca.
4 Bamboo and grass papers.
5 Wood cellulose papers.
   Chemical or mechanical wood pulp.
6 Papers from miscellaneous materials.
   Wastes of industries, in which fiber is not the chief product.
   Barks, leaves, down, hairs, etc.
   Bast, bark, and wood of shrubs and similar materials used together.

These are by no means the only classifications, but show the general classes which are to be considered in our study of papermaking materials.

Evaluation of a Papermaking Material.

William Raitt, of India, has given certain considerations regarding the tests to be applied to a new source of papermaking material. While all of these do not apply at the present time, they are given as originally proposed by Raitt (World's Paper Trade Rev.; Paper Trade Journal, April 15, 1909).

1 "It must have no value for any other economic purpose, neither to the spinner, rope maker, nor, to any exclusive extent at least, to the feeder of cattle.
2 "It must be a free gift of nature, of spontaneous self-sown growth, capable of natural reproduction, and not liable to exhaustion under a reasonable system of cropping. Its periodic removal must not imply an attack upon any form of capital wealth.
3 "It must mature annually, or at periods not exceeding three years, so that a pulp factory can obtain supplies from the area surrounding it in perpetuum.
4 "No fiber requiring cultivation is admissible. This does not, of course, apply to fibrous material obtained as a by-product, *e. g.*, straw as a waste from grain cultivation.
5 "No material requiring manual or mechanical manipulation for the separation of the fiber from the body of the plant

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is admissible, the cost of such separation being prohibitive, and such fibers being invariably of greater value to the spinner.

6 "Its habit must be gregarious and in sufficient local abundance to bring cost of cutting and collection within economic limits, a plant which grows in tufts or patches at long distances apart not being admissible.

7 "It must contain at least 30% of cellulose. This is an item which may vary in accordance with the local cost of other factors, but I think it is taking safe ground to assume that under no conditions will a yield of less than 30% pay.

8 "The total quantity available within economic collecting radius of a mill site must be sufficient to produce at least 2,500 tons of pulp annually. This is also a figure which must vary in accordance with the cost of other factors. Generally it will be much higher. I place it at that, because there are locations where the other conditions are so favorable that even this quantity will pay, and because it is doubtful whether any local advantages could bring a smaller quantity on to a profitable basis.

9 "No material is admissible which does not grow in a locality possessing cheap labor, and water for manufacturing uses.

10 "And it must grow within economic range of power, lime, and transport to seaport."

A study of these requirements would indicate that wood is probably the only material that fulfills these requirements at all perfectly. We know, however, that esparto has been successfully used for many years in Europe, and that straw, bamboo, bagasse, reed, cotton linters and other materials have been commercially used at various times. The success of any material of this kind must depend upon local conditions.

Method of Study.

Hofmann (1873), in discussing substitutes for rags as a raw material for papermaking, says:

"At present, when paper and papermaking have become, through more universal education, matters of importance to everybody, men, from almost all walks of life, consider it their vocation to discover new substitutes and methods of working them. They have never studied papermaking, are not aware that thousands of the best brains have been racked, and that hardly a plant exists which has not been tried or proposed for this purpose. We observe therefore the strange phenomena that now and then substances are proposed, and patents taken out, for new processes of making paper, which have perhaps been tried and condemned many years ago."

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Because of this fact, it seems very desirable that our investigators adopt a uniform method of study and of reporting their results. At present we seem to be content to say that a given fiber contains such a percentage of cellulose, or that it gives such a yield of bleached pulp. The French school of papermaking has worked out a much more comprehensive method of study, which is described in detail by A. Ruby, engineer of the Berges Paper Mills, Iseres, France. He says [Papier, Sept., 1918; Paper xxiii, No. 18, 11 (Jan. 8, 1919)]:

"To fulfill its purpose, this technological index, among its many qualifications, should be able to furnish a complete record for the manufacturer consulting it, inform him as to the quality of the pulp, the yield of cellulose that could be claimed for it, enable him to determine the most suitable apparatus and decide on its proportions, inform him as to the nature and the quality of chemical substances to be set to work, and finally furnish him with all the data required in arriving at a cost price.

"The difference so frequently occurring between the promises of the laboratory and the results obtained in the mill, proceeds, almost always, from the obscurity in which some points have been left by the experiments. The technological index file must, therefore, be complete and precise. It should give, so far as possible, figures. It should specify the methods of analysis employed, above all, in the quantity of cellulose, where the results vary with the process."

It could be carried out, according to the following general plan:

1—*Description of the raw material.*
Scientific name.
Popular name.
Where grown.
Available quantity.
Appearance.
Present use.

2—*Study of the physical characteristics.*
Density.
Hardness.
Homogeneity.

3—*Study of the chemical characteristics.*
Water content.
Resins, fats and waxes contained.
Amount of ash.
Aqueous extract.
Nature and volume of the incrusting substance.
Proportion of cellulose.

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4—*Study of treatment and its facility.*

(*a*) Cleaning, dusting and loss (apparatus).

(*b*) Sorting and loss (apparatus).

(*c*) Preliminary grinding or cutting and loss (apparatus).

(*d*) Digestion.

- Density of digester charge.
- Nature of the hydrolytic agent: soda, bisulfite of lime, etc.
- Quantity necessary and concentration.
- Temperature, pressure and period of cooking.
- Loss in cooking.

(*e*) Grinding and duration of grinding (apparatus).

(*f*) Grinding to half stuff.

(*g*) Color and cleanliness of the unbleached pulp.

(*h*) Bleaching.

- Quantity of bleaching agent necessary, ratio according to active chlorine.
- Temperature necessary.
- Degree of whiteness obtained.
- Loss in bleaching.

(*i*) Beating.

- Adaptability of the stuff for making slow or greasy pulp.
- Balling or knotting.

(*j*) Formation into sheets.

5—*Quality of the cellulose.*

Character of fiber.

Amount of accessory elements.

Fiber:

- Length.
- Thickness.
- Felting capacity.
- Thickness of the membrane.
- Influence on polarized light.
- Tensile strength.
- Homogeneity.
- Flexibility.
- Special characteristics.
- Microchemical characteristics.

Accessory elements:

- Nature.
- Dimensions.
- Special characteristics.
- Microchemical characteristics.
- Value of the pulp considered as an aggregate.

6—*Predominant character of this raw material.*

7—*Comparison with other recognized materials in use.*

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Application of the System.

Ruby gives the following example of the application of his scheme of indexing, using a plant of the family Thymelæaceæ as his subject:

1—*Description of the raw material.*

Scientific name: *Thymelæa microphylla.*

Popular name: Metnane (Arabic).

Where grown: Algeria.

Abundance: Plant widely distributed. Borders of Tell and Sahara.

Appearance: Shrub, of which the branches, of the average thickness of a finger, are covered with a thick fibrous bark.

Present use: Used as fuel; has no value as fodder. The Arabs sometimes make yarn from the bark.

2—*Study of the physical characteristics.*

Density: 0.55.

Hardness: Soft.

Homogeneity: Substance but slightly homogeneous, the bark is very rich in fibers, but the outermost branches are almost destitute of it. On the other hand the bark contains very fine fibers, much superior to those in the wood of the shrub.

3—*Study of the chemical properties.*

Amount of water: 10.6 per cent.

Amount of resins, fat and wax: 0.9 per cent.

Ash content: 1.5 per cent.

Aqueous extract: 10.5 per cent.

Nature of the incrusting substance and contents: Lignin, pectin, 55 per cent.

Volume of cellulose.—The quantity of cellulose, determined by the Cross and Bevan chlorination method, runs up to 32 per cent of the gross weight of the thymelæa. There must be understood under this figure, the *total* cellulose, fibrous, and nonfibrous, contained in the bark and the wood of the shrub.

The yield of cellulose of the fibrous strands forming the bark alone, is 29.5 per cent.

4—*Study of the treatment and its facility.*

(*a*) Cleansing
(*b*) Sorting
(*c*) Cutting

} The woody fibers of thymelæa are slender and insignificant, those of the bark are very fine and worthy of interest.

The preliminary treatment will consist in separating the fibrous strands of the bark which should be digested by themselves. This separation could be effected, either by hand, by the natives at the time of gathering or by means of a barker composed of a rolling cutter, followed by a fan effecting a separation by gravity in a settling chamber.

The weight of the fibrous strands may be estimated as 30 per

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cent of the gross weight of the branches: the loss by sorting, if we count as anything the wood of the thymelæa, therefore amounts to 70 per cent.

(*d*) *Digesting.*—Density of the charge for digesting. In pieces of about 5 centimeters (2 inches): 100 kilograms (220 lbs.) per cubic meter (250 gallons).

Nature of the hydrolytic agent. The incrusting substance consisting for the most part of pectcellulose, the alkaline treatment is plainly indicated. The hydrolytic agent should therefore be soda, or causticized carbonate of soda.

Quantity necessary and concentration. The quantity of soda necessary is 10 per cent, estimated in NaOH, of the gross weight of the fibrous strands.

The best concentration is 6° Baumé.

Temperature, pressure, period of cooking. The cooking should be done at atmospheric pressure, at 100° and should then be continued for three hours. Nevertheless, cooking under 3 kilograms pressure is preferable and the period of cooking is then reduced to two hours.

Loss in cooking: 60.5 per cent of the weight of the strands cooked.

Grinding. Unnecessary.

Grinding to half stuff. This operation, necessary for the separation of the fibers of the cooked strands, involves no peculiarities.

Color and cleanliness of the unbleached pulp. The unbleached pulp of Thymelæa microphylla is clean and in color it can be compared with unbleached spruce bisulfite pulp.

(*h*) *Bleaching. Quantity of bleaching agent.* Pulp easy to bleach by means of 3 parts of chlorine for 100 parts of dry pulp.

Temperature. The operation is assisted by a rise in temperature to 80°.

Degree of whiteness obtained. Snow white.

Loss in bleaching. Ten per cent.

(*i*) *Beating. Adaptability of the pulp for becoming greasy or slow.* Thymelæa becomes *greasy or slow* as readily as spruce pulp.

Balling or knotting not to be feared on account of the length of the fibers.

(*j*) *Formation in sheets.* The pulp of Thymelæa can be formed into extremely fine sheets without any difficulty.

5—*Quality of the cellulose extracted from the fibrous strands of the bark.*

Content in fibers: Ninety-five per cent.

Contents in accessory elements: Five per cent.

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Fibers:
Length: 5 to 8 millimeters.
Thickness: 12 to 13 thousandths of a millimeter.
Felting capacity equals 1-500; remarkable.
Thickness of the membrane: Four to 5 thousandths of a millimeter.
Influence of the membrane on polarized light: Great birefringent power.
Toughness: Considerable toughness, resembling that of rags.
Homogeneity: Very homogeneous.
Flexibility: The fibers are particularly flexible; they bend and curve in every direction, without revealing the slightest fracture.

Microchemical character. The fibers are colored violet by the action of chloriodide of zinc, blue by nitrated iodide of calcium.

Accessory Elements:
Nature: Epidermic cellules.
Dimensions: Thirty to 40 thousandths of a millimeter.
Microchemical characteristics: Violet coloring by chloriodide of zinc, blue by nitrated calcium iodide.

Summary: The cellulose extracted from the bark of thymelæa considered as a whole—fibers and accessory elements—is very fine, being almost exclusively fibrous.

6—*Predominant features of this pulp*—Toughness, flexibility, length of fibers.

7—*Comparison and utilization*—The cellulose of the bark of *Thymelæa microphylla* is definitely comparable with that of other thymelæaceæ: Edgeworthia, Daphne, and Wickerstroemia and could be employed in the manufacture of fine papers in which strength is required.

Conclusion—Thymelæa microphylla contains cortical and ligneous fibers. The first named are remarkable, long, strong, flexible, silky, the latter very inferior, thin, fragile and lacking in felting capacity. The cellulose obtained from the bark consequently is alone interesting and very interesting. Unfortunately its yield, in relation to the whole, is very small, only 9 per cent, and for this reason its employment is limited.

Conditions in the United States.

Very recently the Forest Products Laboratory at Madison has concluded that American conditions are deemed unsuitable for plant fiber paper. They say:

1. "Plant stalks, straws, grasses, etc., usually contain a large percentage of pith, giving pulps low in fiber content and requiring high chemical consumption.

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2. "Material of this type represents seasonal crops, so that facilities must be provided for the storage of a large volume of the stalk in order to permit the paper mill to operate throughout the year. The susceptibility of such material to decay adds greatly to the costs and difficulties of storage.
3. "Due to the bulkiness of these materials the digester charge is reduced, thereby reducing the yield and increasing overhead costs proportionately.

"Some of these fibers, such as straws, are being pulped at the present time for use in the manufacture of corrugated board and cheaper board products. Pulp of this nature, however, does not compare with a refined pulp such as sulfite or rag stock; it can be used only for special purposes and not in the manufacture of newsprint or high-grade paper. Plant fibers of this nature are being reduced commercially in Europe where economic conditions and the scarcity of wood permit their utilization."

Griffin [Paper Trade Journal lxvi, No. 6, 93 (Feb. 7, 1918] quotes Nathan A. Cobb, of the Department of Agriculture, in support of his contention that the annual plants cannot replace wood.

"'Wood is largely made up of fibrous cells. There are a few cells that are not fibrous, and the proportion by weight is comparatively small. This is reversed in the case of annual plants, in which the cells that are not fibrous exceed in volume the fibrous matter. This is a general statement which holds true throughout the whole vegetable world outside of the woods.

"'Thus the function of the annual plant, generally speaking, is not the development of a valuable stalk, as in the forest tree, but the production of flower or fruit, and having done this the plant dies, leaving behind its waste residues of stalks.'

"This statement is so reasonable and clear that it ought to settle the question, once for all, that there is no possibility of the great paper industry, established upon wood, subsisting on the waste stalks of annual growth."

In spite of these conclusions, and they are supported by any number of other observers, the papermaker may find himself forced to a consideration of such materials as bamboo, bagasse, cotton linters, and annual plants because of the shortsighted policy of our nation as a whole regarding the question of reforestation. It is the fact that these materials can be produced in a comparatively short period of time, while a forest is a matter of a lifetime, that brings them to the front at this time.

Scope and Plan of the Bibliography.

No one realizes the shortcomings and limitations of the following bibliography more than the compiler. The first and most serious

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limitation is due to the fact that nowhere in the United States is there a complete set of the foreign papermaking journals. These conditions are best realized by an examination of Clark's List as published in Paper xxi, No. 4 (Oct. 3, 1917). This lack is the greater because of the fact that prior to 1907 there was no abstract journal which covered consistently the papermaking materials. Since that time the chemical side has been very well covered by Chemical Abstracts, and recently the whole industry has been covered by the Committee on Abstracts of the Technical Association of the Pulp and Paper Industry. For this reason, it is true that probably the greater portion of the early work is not covered in this reading list.

The papermaking materials have been listed in dictionary style under the common and botanical names, the references being given only under the latter. Oftentimes it has been hard to properly identify the material in question. In most instances it has been necessary to use the botanical name given by the author, since there was no way to check these. Certain obvious errors have, of course, been corrected.

Mention should also be made of the fact that the large number of woods commonly used in papermaking are not listed. The list is composed largely of vegetable fibers other than wood, though a few of the less common varieties are included. In nearly all cases, the references refer to actual experiments, with or without success, with the material, and not a mere mention of the fact that the material might be suitable for papermaking.

In view of the fact that numberless books and periodical articles refer to many papermaking materials, it has been thought best, in order to save space, to list these books and articles under the author (or title) in the dictionary arrangement, and to refer, under each material, to the author, and the year of publication.

It is the wish of the compiler to eventually complete this list and he therefore requests that all persons using this be kind enough to forward him all omissions and corrections which they may discover. This cooperation is absolutely necessary to secure the end desired by the Committee on Bibliography.

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Artichoke.
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Artiplex.
Davis.

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Piette.

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15. Typhaceae.
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20. Dead leaves.
21. Pine needles.
22. Waste fiber.
23. Asphodel (branches and roots).
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Watt.

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Mueller.

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Davis.
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Liotard.

Ficus indica.
Liotard, page 7.

Ficus morus. Mulberry.
Liotard.

Ficus natalensis.
Juritz, page 76.

Ficus racemosa. Indian fig.
Liotard.

Ficus religiosa. Peepul tree.
Liotard.

Ficus speciosa.
Royle.

Fig tree. See *Ficus.*

Fimbristylis spadicea.
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Fir cones.
Davis.

Fire weed. See *Epilobium angustifolium.*
See *Erecthites heracifolia.*

Flag. See *Iris.*
See *Typla.*

Flame tree. See *Sterculis acerifolia.*
See *Sterculis foetida.*

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Flax-cotton. See *Fibrila.*

Fleabane. See *Erigeron.*

Fleurya peduncularis.
Leighton, 1918.

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Floss silk.
Archer.

Foeniculum. Giant fennel.
Charpentier, page 29.

Forster's palm lily. See *Cordyline australis.*

Fourdrini.
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Davis.

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Davis.
Phillips, 1915, page 257.

Gahnia radual. Black reed.
Dodge, C. R., 1897, page 170.

Gahnia trifida. Awned saw edge.
Lightfoot, Bull. No. 11, page 33.

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Galangal. See *Cyperus lucidus.*

Galega officinalis. Goat's rue.
Davis.

Galega orientalis. Goat's rue.
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Galingale. See *Cyperus lucidus.*

Galingale rush. See *Carex pseudo-cyperus.*

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Piette.

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van den Corput.
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Gnerium argenteum. Pampas grass.
Dodge.

Gnidia erocephala.
van den Corput.
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Goat's rue. See *Galega.*

Goldenrod. See *Solidago.*

Gombo. See *Hibiscus esculentus.*

Gorse. See *Ulex europaenus.*

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Pisum arvense.
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Pita. See *Agave americana.*

Pittesporum cornifolium. Currijong.
Davis.

Pittesporum crassifolium. Thick leaved pittesporum.
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Plagianthus betulinus. Ribbon tree of New Zealand.
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Pousolsia. See *Memorialis pentandra.*

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Davis.

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Quitch. See *Triticum repens.*

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RAITT, WILLIAM.
Fiber prospecting. World's Paper Trade Rev. li, 569; C. A. iii, 1458.
RAITT, WILLIAM.
Fiber prospecting. The result. Paper Trade J., Apr. 15, 1919.
RAITT, WILLIAM.
Indian grasses as raw material for paper. Indian Engineer liv, No. 22, 297-298; Rev. papeterie xli, No. 5, 81-84.
RAITT, WILLIAM.
New fibers for paper. I, II, III, IV. Tropical Agriculturist xxxii, xxxiii (May-Aug., 1909).
RAITT, WILLIAM.
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RAITT, WILLIAM.
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Rajmahal creeper. See *Marsdenia tenacisima.*
Ram turai of India.
Watt.
Ramie. See *Boehmeria nivea.*
Rape. See *Brassica campestria.*

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Raphia ruffia. Raffia palm.

Dodge, C. R., 1897, page 276.

HUNT, W. H. Raffia fiber is used for cigarette paper. Paper Mill, Aug. 16, 1902, page 32.

Raphia vinifera. Bamboo palm.

Bull. Misc. Inform., Kew, 1895, pages 88-92; Selected Papers, vol. I, page 232.

Dodge, C. R., 1897, page 277.

Raspberry. See *Rubus.*

Rattan. See *Calamus verus.*

Ravenala madagascariensis. Giant wild plantain.

Davis.

RAW material for pulp and paper.

Pulp Paper Mag. Can. iv, No. 11, 281-283 (Nov., 1906).

Red alder. See *Alnus oregona.*

Red silk cotton. See *Bombax malabaricum.*

Reed. See *Arundo donax.*
Phragmites communis.
Phragmites vulgaris.

Reed grass. See *Glyceria aquatica.*

Reed mace. See *Typha elephantia.*

Rhea. See *Boehmeria nivea.*

Rhubarb.

Archer.

Ribbon tree. See *Plagianthus betulinus.*

Rice. See *Oryza sativa.*

Rice husks.

UTILIZATION of rice and its by-products. Bull. Imp. Inst. xvi, No. 1, 23 (1918).

Rice, wild. See *Zizania aquatica.*

Rice paper plant. See *Aeschyomene paludosa.*

Rice root grass. See *Epicampes macroura.*

RICHMOND, GEORGE F.

Philippine fibers and fibrous substances—their suitability for papermaking. Philippine J. Sci. i, 433-462; 1075-1081 (1906); ii, 81-112 (1907); v A, 233-255 (1910); C. A. i, 1621, 1622; ii, 1185; v, 1513; J. Soc. Chem. Ind. xxv, 863; xxvi, 274, 940; xxix, 1450.

Ricinodendron rautanenii, Mungongo.

INVESTIGATION of materials suggested for the manufacture of paper. Bull. Imp. Inst. xvii, No. 2, 150-152 (1919).

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CELLULOSE from *Ricinus arboreus giganteus* (Hortus Wulle). Memoranda of Heinrich Wulle in Naples. Papier-Ztg., 1909, No. 13, 470; Paper Making xxviii, 279 (1909)

ROESSLER, L. von. New plant fiber. Papierfabr., Festschrift, 1910, 42-46.

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Ricinus communis. Castor oil plant.

Dodge, C. R., 1897, page 280.

LOOMIS, BURDET. Possibilities of the castor oil plant. Paper xxii, No. 19, 527 (July 17, 1918); Pulp Paper Mag. Can. xvi, 959.

PAPER from the castor oil plant. Paper Making xxviii, No. 7, 279 (July, 1909).

Watt, vol. VI, part I, page 508.

River rush. See *Isolepus nodosa.*

River weeds.

PAPER from river reeds. Paper xxii, No. 4, 65 (Apr. 3, 1918).

Rockweed. See *Fucus vesiculosus.*

Roots.

Lindsay.

Rosaceae. Roses. Brambles.

Lindsay.

Rose mallow. See *Hibiscus moscheutos.*

Rosella fiber.

ROSELLA fiber in papermaking. Agr. News xviii, 201 (1919).

ROSTAING, LEON, ROSTAING, MARCEL, and DU SERT, FLEURY PERCIE.

Précis historique, descriptif, analytique et photomicrographique des vegetaux propes à la fabrication de la cellulose et du papier. Paris, H. Everling (pref., 1899).

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Historical, descriptive, analytical, and photomicrographic compendium of plants adapted to the manufacture of cellulose and paper.

Roussa grass. See *Andropogon martini.*

ROYAL GARDENS, KEW.

Bulletin of Miscellaneous Information. Addition Series, II. London, 1898. 280 pp.

ROYAL GARDENS, KEW.

Selected papers from the Kew Bulletin. I. Vegetable fibers.

ROYLE, JOHN FORBES.

The fibrous plants of India fitted for cordage, clothing, and paper. With an account of the cultivation and preparation of flax, hemp, and their substitutes. London, Smith, Elder & Co., 1855.

1 p. 1 (v)-xiv, 403 (1) p. illus. 22.5 cm.

Rozelle hemp. See *Hibiscus sabdariffa.*

Rubiaceae. Madder.

Davis.

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Rubus. Bramble. Berry bush.
Davis.
Lindsay.
McElhenie, 1910.

RUBY, A.
New raw materials. Proposed technological index file for papermaking materials. Papier; Paper xxiii, No. 18, 479-481 (Jan. 8, 1919).

Rushes.
McElhenie, 1910.
Munzell.
See also *Ecdericola monostachya.*

Rutaceae. Rue family.
Davis.

Rye. See *Secale cereale.*

Rye grass. See *Hordeum murinum.*
See *Lolium perenne.*

S

Sabai. See *Ischaemum angustifolium.*

Sabal palmetto. Cabbage palmetto of Florida.
Dodge, C. R., 1897, page 281.
Spon, vol. I, page 994.

Saccharum arundinaceum.
Raitt, 1913.

Saccharum fuscum. See *Savannah grass.*

Saccharum mara.
Valenta.

Saccharum munja. *Saccharum sara.* Munj grass. Munja. Sara grass.
Cross, Bevan and King, page 56.
Dodge, C. R., 1897, page 65.
Liotard, page 65.
Raitt, 1909.
Raitt, 1913.
Richmond, C. F., 1906.
Spon, vol. I, page 994.
Valenta, 1904.
Watt, vol. I, page 109.

Saccharum narenga. Savannah grass.
Raitt, 1913.

Saccharum officinarum. Sugar cane.
Höhnel, page 116.
OKAZAKI, U. Paper pulp from sugar cane leaves. U. S. Patent 1,278,199. Sept. 10, 1918. C. A. xii, 2,440; Paper xxiv, 117.
See also *Bagasse.*

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Saccharum spontaneum. Talahib grass. Savannah grass.
Annual Report of the Board of Scientific Advisers for India, 1916-1917; Bull. Imp. Inst. xvi, No. 4, 577 (1918).
Boomer, 1919.
Brown and Fischer, Bull. No. 16.
Liotard, pages 19, 65.
Raitt, 1913.
Richmond, 1906.

Sacking tree. See *Antiaris saccidora.*

Sage. See *Salvia.*

Sagittaria sagittifolia. Arrowhead.
Hannan, page 127.

Sago palm. See *Arenga saccharifera.*
See *Colocasia antiquorum.*
See *Livistonia mauritiana.*
See Metroxylon sagu.

SAHLIN, E. G.
Textile fiber plants of the Philippines and their suitability as raw material for cellulose. Svensk. Pappers-Tidning, 1910, 3, 23, 27.

Sal bark. See *Shorea ribusta.*

Salix alba. Osier. Willow.
Davis.
Mueller.

Salt bush. See *Atriplex halimus.*

Salt Grass. See *Spartina juncea.*

Salvia cannariensis. Sage.
Davis.
IMHAUS, E. Paper pulp from sage. French Patent 355,245. June 15, 1905. J. Soc. Chem. Ind. xxiv, 1185.

Sambucus canadensis. Elder.
Davis.

Sand grass.
SANDERSON, L. Manufacture of brown paper from sand grass. U. S. Patent 614. Feb. 22, 1838.

Sandoricum vadalianum. Santol.
Richmond, 1907.

Sansevieria cylindrica. Ife hemp.
Davis.
Dodge, C. R., 1897, page 287.

Sansevieria guineensis. African bowstring hemp. Moorva.
Dodge, C. R., 1897, page 287.
Mierzinski, page 19.
Richmond, 1906.

Sansevieria latifolia.
Davis.

Sansevieria thyrsiflora.
Leighton, 1918.

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Sansevieria roxburghiana. Moorva.
Dodge, C. R., 1897, page 289.

Sansevieria zeylanica. Ceylon neyanda. Bowstring hemp.
Boomer, 1919.
Dodge, C. R., 1897, page 290.
Dodge, J. R., Annual Report, Dept. of Agr., 1879.
Juritz, page 74.
Liotard, page 6.
Spon, vol. I, page 995.
Watt, vol. VI, part I, page 109.

Santol. See *Sandoricum vidalianum.*

Sara grass. See *Saccharum munja.*

Sarcochlyamys pulcherrima. Nettle.
van den Corput.

Savannah grasses.

BAMBOO and Savannah grasses as papermaking materials. Paper Maker lvii, No. 3, 288 (Mar. 1, 1919); Paper xxiv, No. 8, 264 (Apr. 30, 1919).

Phillips, S. C., 1915, pages 143-149.

PULP for the whole world in India. Paper xxiv, No. 13, 489,506 (June 4, 1919).

RAITT, WM. Cellulose in India. Paper Trade J. lviii, No. 1, 46-52; C. A. viii, 1203.

RAITT, WM. The Savannah grasses of Northern and Central India. An investigation of their possibilities for papermaking purposes. Indian Forest Records v, part III, 1-44 (Sept., 1913); Paper xiii, No. 19, 15-16, 34; No. 20, 17-20; No. 21, 20-21; No. 22, 20-21 (Jan. 21-Feb. 11, 1914); Paper Maker xlvii, No. 1, 71-79 (Jan. 1, 1914); World's Paper Trade Rev. lxi, No. 3, 112-113; No. 4, 162-166; No. 5, 211-213 (Jan. 9-30, 1914); Papierfabr. xii, No. 5, 124-129 (1914); C. A. viii, 1204-1205.

See also the following (the arrangement is Raitt's, in order of importance as papermaking materials):

Saccharum spontaneum.
Saccharum arundinaceum.
Saccharum munja.
Saccharum narenga.
Anthistiria gigantea (arundinacea).
Anthistiria gigantea (villosa).
Imperata arundinacea.
Eragrostis cynosuroides.
Arundo donax.
Phragmites karka.

Saccharum fuscum.
Andropogon intermedius.
Andropogon squarrosus.

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Savannah grasses—Continued

Andropogon nardus.
Andropogon contortus.
Trianthus ravennae.
Aristida cyanantha.
Triraphis madagascariensis.

Sawdust.[1]

MANUFACTURING paper pulp from sawdust. Paper xxiv, 1137 (1919).

MARX, R. J. Sawdust as raw material for paper. Tidskrift papirindustri, July 15, 1918.

NEW way of making paper from sawdust. Current Opinion lxv, 201-202 (Sept., 1918).

OBSERVATIONS on sawdust pulp. Paper xxii, 645 (Aug. 14, 1918).

PAPER from sawdust. Account of the work of the Saw Dust Pulp and Paper Co. Eng. News xii, 305 (1884).

SAWDUST. Paper Mill xli, No. 27, 7 (1918); Paper xxiii, 35.

SAWDUST for papermaking. Paper Maker lvi, No. 5, 453 (Nov. 1, 1918); Paper Makers' Mo. J. lvi 133, 167 (May 15, June 15, 1918).

SAWDUST paper. Paper xxiv, 148 (1919).

SPARRE, P. A. Paper from sawdust. English Patent 29,-118. Dec. 31, 1909. C. A. v, 2947.

STRACHAN, JAMES. Sawdust as a material for papermaking. World's Paper Trade Rev., July 12, 1918; Paper xxii, 609-610 (Aug. 7, 1918).

USE of sawdust in papermaking. J. Soc. Chem. Ind. xxxvii, 189-190 R; Paper xxiii, 360; Paper Makers' Mo. J. lvi, 204 (July 15, 1918).

WOOD pulp from sawdust. World's Paper Trade Rev.; Paper xxiii, 256 (Nov. 13, 1918).

Saw grass. See *Cladium effusum.*

Saw palmetto. See *Serenoa serrulata.*

SCHAEFFER, JACOB CHRISTIAN.

Jacob Christian Schaeffers sämtliche Papierversuche. 2 Aufl. nebst ein und achtzig Mustern und dreizehn Theils illuminierten Theils schwarzen Kupfertafeln. Regensburg, Gedruckt mit zunkelischen Schriften, 1772.

6 v. in 1. 14 pl. (2 fold., 8 col.) samples. 19.5 cm.

Jacob Christian Schaeffer's—collected researches on paper. 2nd. ed. With 81 *samples and* 13 *copper plates, part black, part colored.*

The samples are specimens of paper and a few textile fabrics, made from different materials. The following are the different specimens of paper to be found in the six volumes:

[1]With a few exceptions only the more recent articles on sawdust are given.

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SCHAEFFER, J. C.—Continued

Vol. I. Jan. 15, 1765. Paper made from poplar down, wasps' nests, sawdust, pine-chips, beech wood, willow wood, willow wood without rags, tree moss, poplar, hop tendrils, hop wood, grapevine outer bark, grapevine inner bark and wood.

Vol. II. Mar. 30, 1765. Paper made from hemp, mulberry, mulberry inner bark, aloe leaves, clematis wood, stinging nettle, willow, bull rush, earth moss, barley, leaves of trees—wintered, cabbage stalks, roof paper made from tow.

Vol. III. Nov. 3, 1765. Paper made from Cyprian asbestos, seed down, thistle stalks, burdock stalks, leaves of the lily of the valley, seed down of the thistle, water moss, Bavarian turf, Hanoverian turf, poplar down thread—knit—woven in colors, plain and printed.

Vol. IV. Jan. 1, 1766. Paper made from silk plant, mallow, orache, spruce fir wood, Artemisia wood, Indian corn, young grapevines, lace from aloe fiber.

Vol. V. Apr. 13, 1767. Paper from genista, pine cones, potatoes—both skins and insides, shingles.

Vol. VI. 1771. Paper from reed, bean leaves, horse-chestnut leaves, tulip leaves, linden leaves, walnut leaves, genista, yellow wood, Brazil wood.

For a description of this book, see Hunter, Paper xxvii, No. 2, 16-18 (Sept. 15, 1920).

Schizostachyum lumampao. Bamboo.

Brown and Fischer, Bull. No. 16, page 15.

Schoenus sphoerocephalus. Bottom bog rush.

Lightfoot.

SCHWALBE, CARL G.

Agriculture and forestry as producers of raw materials for papermaking. Papier-Ztg. xxxix, No. 10, 303-304; No. 11, 343-344 (1914); C. A. viii, 1345.

Scilla rigidifolia. Leaves.

Juritz, page 84.

PAPERMAKING materials. Bull. Imp. Inst. xii, 42-45 (1914); Paper xiv, No. 13, 21 (June 10, 1914); J. Soc. Chem. Ind. xxxiii, 477.

Scirpus fluviatilis. Club rush.

Lightfoot, Bull. No. 11.

Lindsay, 1858.

Phillips, 1915, page 259.

Scirpus lacustris. Bulrush. Mat rush. Marsh gladden. Tule grass.

Dodge, C. R., 1897, page 291.

Mueller, 1867, page 31.

Schaeffer, 1772.

Spon, vol. I, page 996.

Strother, 1883.

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Scirpus lacustris occidentalis. Tule grass.
Mierzinski, page 12.

Scirpus litteralis. Rush.
NORTON, J. S., and WIRTZ, Q. Papyrus for papermaking. World's Paper Trade Rev. xlvii, 737-742 (May, 1907); C. A. ii, 180.

Scirpus maritimus. Salt marsh club rush.
Mueller, 1867, page 31.

Scirpus palustris. Marsh rush.
Davis.

SCOTT, JAMES.
Some notable fibers. Their striking contrasts. Paper Maker xlviii, No. 5, 677-678 (Nov., 1914); Paper xvi, No. 9, 14-15 (May 12, 1915).

Screw pine. See *Pandanus odoratissimus.*

Scriptural reed. See *Arundo donax.*

Sea coast rush. See *Diannella longifolia.*
See *Juncus maritimus.*

Sea grass. See *Zosteris marina.*

Sea Island cotton. See *Gossypium barbadeuse.*

Sea lyme rush. See *Elymus arenarius.*

Sea mallow. See *Lavatera maritima.*

Sea matweed. See *Ammophilis arenaria.*

Sea reed. See *Ammophilia arenaria.*

Sea rush. See *Juncus maritimus.*

Sea tang. See *Zostera marina.*

Sea weed. See *Algae marina.*

Sea wrack. See *Fucus vesiculosus.*

SEARCH for new papermaking fibers.
Paper Making xlvii, 41 (Jan., 1914); xlix, 54-55 (Jan., 1915); lii, Annual No., 1915-1916, 45-46.

Sebesten. See *Cordia myxa.*

Secale cereale. Rye.
See *Straw.*

Secrate.
Davis.

Sedge grass. See *Carex appressa.*

Sedge reeds.
Norton, 1910.

Seed down.
Schaeffer, 1772.

Seronoa serrulata. Saw palmetto.
Dodge, C. R., 1897, page 293.
Dodge, 1910.
MELL, C. D. The saw palmetto, a neglected fiber in the South. Paper Trade J. xlii, No. 7, 181-182; C. A. x, 1433.

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Sesbania aculeata. Dunchee. Danchi. Dhonchi.
Dodge, C. R., 1897, page 294.
Mierzinski, page 20.
Royle, 1855, page 391.

Sesbania cannabina.
Mueller, L., 1877.

Setburosa. See *Daphne cannabina.*

SETLIK, B.
Japanese leather and oil papers. Paper iv, No. 6, 11-12 (July 26, 1911).

SETLIK, B.
Japanese papers. Papier-Ztg, xxxii, 2854-2855, 3198-3200, 3738-3739, 4018-4020 (Aug.,-Nov., 1907); C. A. ii, 587.

Shaenus sphaerocephalus. Bottom bog rush.
Lightfoot, Bull. No. 11.

Sheathed galingale. See *Cyperus vaginatus.*

Sheathed rush. See *Juncus.*

Shining rush. See *Cyperus lucidus.*

Shoe flower. See *Hibiscus rosa-sinensis.*

Shorea robusta. Sal bark.
CROSS, C. F., and BEVAN, E. J. Sal bark (*Shorea robusta*) and some physiological problems. J. Soc. Dyers Colourists xxxv, 68-70 (1919); C. A. xiii, 2277.

Short staple cotton. See *Gossypium herbacium.*

Sida. See *Sida rhombifolia.*

Sida retusa. Queensland hemp.
Lightfoot, Bull. No. 11, page 33.
Mierzinski, page 14.
Wild plants, 1914.

Sida puchella. Victorian hemp.
Davis.

Sida rhombifolia. Queensland hemp. Sida. Tea plant.
Dodge, C. R., 1897, page 296.
FIBERS from different sources. Bull. Imp. Inst. xv, 7-23 (1917).
Mierzinski.
Piette.
Spon, vol. I, page 996.

Sida rhomboida. Barriala.
Guilfoyle.

Sida tiliaefolia.
Davis.

Silk.
Piette.

Silk cocoon refuse.
Munsell.

Silk grass. See *Karatas plumieri.*

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Silk plant. See *Asclepias syriaca.*

Silk weed of the United States. See *Asclepias syriaca.*

SINDALL, ROBERT W.

Indian papermaking fibers. Paper Makers' Mo. J. xliii, No. 11, 394-395; No. 12, 431-432 (Nov. 15, Dec. 15, 1905); xliv, No. 2, 46-47; No. 3, 91-92; No. 4, 122-123 (Feb.-Apr., 1906).

SINDALL, ROBERT W.

The manufacture of paper, with illustrations and a bibliography of works relating to cellulose and papermaking. London, A. Constable and Co., Ltd., 1908.

x, 275 p. incl. illus., tables. 21.5 cm. (Half title: The "Westminster" Series.)

SINDALL, ROBERT W.

Paper technology, an elementary manual on the manufacture, physical qualities and chemical constituents of paper and of papermaking fibers. 2d. ed., rev. London, C. Griffin and Co., Ltd. 1910.

xv, 269 p. front. illus., xiii pl. 23 cm.

SINDALL, ROBERT W.

Raw papermaking material problem. World's Paper Trade Rev., Mar. 1, 1918; Paper xxii, 321-322 (May 29, 1918).

SINDALL, ROBERT W.

Report on the manufacture of paper and paper pulp in Burma. Prepared by order of the Government of India. Rangoon. Office Supt. Govt. Printing, Nov., 1906.

36 p. map. fol.

SINDALL, ROBERT W.

Wood pulp and papermaking materials. Paper Maker lv, 250-251 (Mar. 1, 1918).

Sisal. See *Agave rigida.*

Sisal grass. See *Agava rigida.*

Sisal hemp. See *Agave rigida.*

SKINNER, R. P.

North African grasses for papermaking. Paper Trade J. xlv, No. 26, 44 (Dec. 26, 1907); C. A. ii, 703.

Slender spike rush. See *Eleocharis acuta.*

Slender sword rush. See *Lepidosperma flexuosum.*

Small rush. See *Juncus pauciflorus.*

Small sheathed rush. See *Juncus vaginatus.*

Soft leaved abutilon. See *Abutilon molle.*

Solidago. Goldenrod.

McElhenie, 1910.

Solidago canadensis. Canada goldenrod.

Dodge, C. R., 1897, page 299.

SOME new papermaking materials.

Bull. Imp. Inst. xv, 1-7 (1915); Paper Makers' Mo. J. lv, 279-280 (Sept. 15, 1917).

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Sorghum halepense. Johnson grass.
South African grasses, 1918.

Sorghum saccharatum. Sorghum cane.
See *Bagasse.*
See *Saccharum officinarum.*

Sorghum vulgare. Millet.
HAAS, B. Use of *sorghum vulgare* in the cellulose industry. Z. angew. Chem. xxxi, I, No. 33, 84 (1918); C. A. xii, 2438.
Montessus de Ballore, page 277.

Sorgo-sucre. See *Chinese sugar cane.*

Sotal tree.
Davis.

SOURCES of papermaking materials.
Paper xiii, No. 20, 20-21 (Jan. 28, 1914); Sci. Am., Jan. 3, 1914.

Sour sop. See *Anona squamosa.*

SOUTH African grasses for papermaking.
Bull. Imp. Inst. xvi, No. 2, 127-134 (1918); Agr. News xviii, 39 (1919); Paper Maker, Intern. No., 1918-1919, 70-72; Paper xxiv, 711; Papier xxii, 117 (1919); C. A. xiii, 515.

Southern moss. See *Tillandsia usneoides.*

Spanish bayonet. See *Yucca aliofoila.*

Spanish broom. See *Genista aculenta.*
See *Sparticum junceum.*

Spanish esparto.
Paper Making xxxiv, No. 4, 120-122.

Spanish grass. See *Stipa tenacissima.*

Sparganium. Bur-reed.
Davis.

Sparmannia africana.
Dodge, C. R., 1897, page 299.

Spartina cynosuroides. Fresh water cord grass. Cord grass. Marsh grass. Bull grass. Thatch grass.
Dodge, C. R., 1897, page 301.
Hannan, page 137.
Lindsay, 1858.
Little, 1910.
REMINGTON, J. S., BOWAK, D., and DIXON, B. Fresh water cord grass as a source of papermaking material. World's Paper Trade Rev. li, 697 (Apr. 23, 1909); Aynsome Annual ii, 22-33 (1910); Papierfabr. vii, 496-497 (May 14, 1909); C. A. iii, 1590; J. Soc. Chem. Ind. xxviii, 540.
Spon, vol. I, page 997.

Spartina gracilis.
Dodge, C. R., 1897, page 301.

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Spartina juncea. Fox grass. Marsh grass. Salt grass. Sea salt grass. Salt marsh grass. Rush marsh grass.

Davis.

Dodge, C. R., 1897, page 301.

McElhenie, 1910.

REMINGTON, J. S., BOWAK, D., and DIXON, B. American salt marsh grass. World's Paper Trade Rev. li, No. 2, 6-8 (Jan. 8, 1909); Aynsome's Annual ii, 12-21 (1910); C. A. iii, 835; J. Soc. Chem. Ind. xxviii, 540.

Spartina townsendii.

PAPER from marram grass and spartina. World's Paper Trade Rev. lxvii, No. 16, 658 (Apr. 20, 1897).

POSSIBLE raw materials for papermaking. Paper Maker lvi, No. 4, 314 (Oct. 1, 1918).

SHRUBSOLE, W. H. Marine grasses for pulp making. Paper Maker lvi, No. 2, 148 (Aug. 1, 1918).

SINDALL, R., and BACON, W. Spartina. Paper Makers' Mo. J. lvi, 132-133 (May 15, 1918).

SPARTINA grass. Paper Makers' Mo. J. lvi, No. 8, 240 (Aug. 15, 1918); Paper xxiii, 207; Pulp Paper Mag. Can. xvi, 1041.

Spartium. Water broom.

Munsell.

Spartium junceum. Spanish broom.

Bull. Misc. Inform., Kew, 1892, pages 53-58; Selected Papers vol. I, page 37.

Dodge, C. R., 1897, page 301.

Hoyer, "Das Papier," 1882, page 8.

Montessus de Ballore, page 276.

Norton, 1910.

Piette.

Spon, vol. I, page 997.

Valetta, 1904.

Spartium scoparium. Wild broom.

Hoyer, "Das Papier," 1882, page 8.

Munsell.

Piette.

Valenta, 1904.

Spatholobus roxburghii.

Phillips, S. C., 1915, page 148.

Spear grass. See *Poa pratensis.*

Spear lily. See *Doryanthes excelsa.*

Sphagnum cymbifolium.

EGOROFF, P., and REMMER, A. Manufacture of paper pulp and half stuff from sphagnum. French Patent 410,835. Sept. 20, 1909. J. Soc. Chem. Ind. xxix, 811.

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Sphagnum japonicum. Tundra moss.

TUNDRA moss for papermaking. World's Paper Trade Rev. lviii, No. 19, 928 (Nov. 8, 1912); C. A. vii, 251.

Sphagnum vulgare.

van den Corput.

Spike rush. See *Eleocharis acuta.*.

Spinach.

CELLULOSE from spinach. Paper Maker lii, No. 6, 538 (Dec. 1, 1916).

Spindle tree. See *Euonymus.*

Spinifex grass. See *Triodia.*

SPON, EDWARD.

Spon's encyclopedia of the industrial arts, manufactures and commercial products. . . . London, New York, E. and F. N. Spon, 1879-1882.

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Dodge, C. R., 1897, page 313.
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Tillandsia usneoides. Long moss. Southern moss. Black moss.
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Lindsay.
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Davis.
Trachycarpus excelsa. Chinese coir palm.
Hannan, page 129.
Trachypogon polymorphus. "Steek grass."
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Travancore sacking tree. See *Antiaris roxicaris.*
Tree mallow. See *Lavatera arborea.*

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Tree moss.
Schaeffer.

Tree nettle. See *Laportea giga.*

Trifolium. Clover.
Davis.

Triodia irritans. Porcupine grass.
Dodge, C. R., 1897, page 313.
Hannan, page 137.
Spon, vol. I, page 998.

Triodis sp. Spinefex grass.
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Earl, 1916.
Piette.
See also *Straw.*

Triticum vulgare. Wheat.
Mueller.
See also *Straw.*

Tritoma recurvata.
Hannan, page 137.

Tritoma uvaria. Poker plant.
Hannan, page 137.

Trophis asper. See *Strebulus asper.*

TROPICAL grasses as papermaking material.
Paper Maker, 1918-1919, page 45.

Trumpet tree. See *Cecropia.*

Tule grass. See *Scirpus lacustris.*

Tulip tree. (Leaves).
Davis.

Tundra moss. See *Sphagnum japonicum.*

Tumeric. (Stem and leaves.)
Davis.

Turf. See *Peat.*

Turkish cornstalk or **wheat.** See *Zea mays.*

Turnip. See *Brassica.*

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Tussilago. Coltsfoot.
Lindsay, 1858.
Villette.

Tussock grass. See *Poa coespitosa.*
See *Xerotes longifolia.*

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Tylophora asthmatica. Pubescent tylophora.
Liotard, page 34.

Typha angustifolia. Bulrush.
Charpentier.
Dodge, C. R., 1897, page 3189.
Lindsay, 1858.
Mueller, 1867, page 33.
Watt.

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Dodge, C. R., 1897, page 321.
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Urtica dioica. Common stinging nettle of Europe.
Cross and Bevan, page 106.
Dodge, C. R., 1897, page 323.
Kirchner, vol. II, page 74.
NETTLE fiber and reed. Wochbl. Papierfabr. xlviii, No. 10, 423-424 (1917); xlix, No. 47, 2395 (1918).
Piette.
Schwarz, 1909.
Strothers, 1883.

Urtica divaricata. Giant nettle.
Davis.
Mueller.

Urtica heterophylla. Neilgherry nettle.
Lindsay, 1858.
Watt.

Urtica incisa. Victorian nettle.
Archer.

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Montessus de Ballore, page 258.
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Piette.

Urtica utilis.
Mueller, L., 1877.

Urtoceae.
Davis.

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Lindsay, 1858.

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Lindsay, 1858.

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See *Poa coespitosa.*
Wolfsbane. See *Aconitum.*
Woolen grass. See *Typha.*
Wormwood. See *Artemisia maxa.*
Wrack. See *Fucus vesiculosus.*

X

Xanthorrhoea minor.
Mueller, L., 1867, page 33.
Xanthorrhoea preissii. Black bay tree.
Phillips, S. C., 1915, page 259.
Xanthorrhoea semiplana. Grass tree.
Earl, J. C., 1916, 1917.
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Xerotes longifolia. Tussock grass. Australian mat rush. Toothed dry-rush.
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Piette.
Yucca baccata.
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Yucca brevifolia. Needle palm.
Davis.
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Yucca draconis.
Mueller.

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Yucca filamentosa. Bear grass. Adam's needle.
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Yucca puberula.
Davis.

Z

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Agr. J. Cape Good Hope	Agricultural Journal of the Cape of Good Hope, The. Cape Town, South Africa.
Agr. News	Agricultural News, The. Advocate Co., Ltd., Broad street, Bridgetown, Barbados.
Am. Forestry	American Forestry. Washington, D. C.
Am. Homes	American Homes and Gardens (Now House and Garden), 19 West 44th street, New York, N. Y.
Am. Sugar Ind.	American Sugar Industry and Beet Sugar Gazette, 145 La Salle street, Chicago, Ill.
Ann. accad. agr. Torino	Turin. Reale academia d'agricoltura. Annali. Vincenzo Bona, Turin, Italy.
Ann. musèe colonial Marseille	Marseille. Musèe colonial. Annales. Marseille, France.
Aynsome Annual	Aynsome Annual. Aynsome Technical Laboratories, Grange-over-Sands, Lancashire, England.
Board Trade J.	Board of Trade Journal. London, England.
Bull. Agr. Intelligence	Bulletin of Agricultural Intelligence and Plant Diseases, Monthly. International Institute of Agriculture, Rome, Italy.
Bull. assoc. chim. sucr. dist.	Bulletin de l'association des chimistes de sucrerie et de distillerie. L. Raimbert, 156 Boulevard Magenta, Paris, France.
Bull. Commonwealth of Australia. Adv. Council Sci. and Ind.	Bulletin of the Commonwealth of Australia. Advisory Council of Science and Industry, Melbourne, Australia.
Bull. econ. gouv. gén. Indo Chine	Bulletin economique de l'Indo Chine. Hanoi, French Indo China.

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Bull. fabr. papier	Bulletin-journal des fabricants de papier. Paris, France.
Bull. Imp. Inst.	Bulletin of the Imperial Institute. John Murray, Albemarle street, London, W., England.
Bull. Misc. Inform., Kew	Bulletin of Miscellaneous Information, Royal Gardens, Kew, England.
Bull. soc. encour. ind. nat.	Bulletin de la société d'encouragement pour l'industrie nationale. 44, Rue de Rennes, Paris, France.
Bull. soc. for. Belg.	Société centrale forestiere de Belgique. Bulletin. F. van Buggenhoudt, Brussels, Belgium.
Bull. soc. hyg.	Bulletin de la société scientifique d'hygiène alimentaire, et d'alimentation rationnelle de l'homme. Masson et Cie., 120 Blvd. Saint-Germain, Paris, France.
Bull. syndicat fabricants papier carton, France	Bulletin syndicat des fabricants de papier et de carton de France.
C. A.	Chemical Abstracts. Charles L. Parsons, Box 505, Washington, D. C.
Can. Municipal J.	Canadian Municipal Journal. Montreal, Canada.
Canadian Patent	Canadian Patent. Patent Office, Ottawa, Ont., Canada.
Cellulosechemie	Cellulosechemie. Otto Elsner, Oranienstrasse 140/42, Berlin S42, Germany.
Centr. Zuckerind.	Centralblatt für die Zuckerindustrie. Vereins Deutscher Zuckertechniker, 8 Guerickstrasse, Magdeburg, Germany.
Chem. Age	Chemical Age. McCready Publishing Co., 118 East 28th street, New York, N. Y.
Chem. Ind.	Chemische Industrie, Die. Weidmannsche Buchhandlung, Zimmerstrasse 94, Berlin, S. W., Germany.
Chem. Met. Eng.	Chemical and Metallurgical Engineering. McGraw-Hill Co., Inc., 10th avenue at 36th street, New York, N. Y.
Chem. News	Chemical News and Journal of Physical Science, The. 16 Newcastle street, Farrington street, E. C. 4, London, England.

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Chem. Trade J.	Chemical Trade Journal and Chemical Engineer, 265, Strand, London, W. C., England.
Chem.-Ztg.	Chemiker-Zeitung. Otto v. Halen, Cöthen, Germany.
Chim. ind.	Chimie & industries. Société de chimie industrielle, 49 Rue de Mathurins, Paris, France.
Commerce Reports	Commerce Reports. Superintendent of Documents, Washington, D. C.
Compt. rend.	Comptes rendus hebdomadaires des séances de l'académie des sciences. Gauthier-Villars, 55 Quai des Grands-Augustins, Paris, France.
Compt. rend. agr., France	Comptes rendus des séances d'académie d'agriculture de France, 18 Rue de Bellechasse, Paris, France.
Consular Reports	Consular Reports. Superintendent of Documents, Washington, D. C.
Cotton Oil Press	Cotton Oil Press, The. Louis N. Geldert, Potter Bldg., Memphis, Tenn.
Country Life	Country Life in America. 116 West 32d street, New York, N. Y.
Current Opinion	Current Opinion. 63 West 36th street, New York, N. Y.
Daily Consular and Trade Reports	Daily Consular and Trade Reports. Superintendent of Documents, Washington, D. C.
Dallas Trade Rev. Ind. Record	Dallas Trade Review and Industrial Record, Dallas, Texas.
Dingler's polytech. J.	Dingler's polytechnisches Journal. Richard Dietze, Verlagsbuchhandlung, Berlin, W. 66, Germany.
Eighth Intern. Cong. Appl. Chem.	Eighth International Congress of Applied Chemistry. Rumford Press, Concord, N. H.
Eng. News	Engineering News (Now Engineering News-Record), McGraw-Hill Co., Inc., 10th avenue at 36th street, New York, N. Y.
English Patent	English Patent. Patent Office, London, England.

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Expt. Sta. Rec.	Experiment Station Record. A. C. True, Office of Experiment Stations, U. S. Department of Agriculture, Washington, D. C.
Fiber and Fabric	Fiber and Fabric. 127 Federal street, Boston, Mass.
Foreign Office Diplomatic and Consular Reports	Great Britain. Foreign Office. Miscellaneous Series. Diplomatic and Consular Reports. H. M. Stationery Office, Imperial House, Kingsway, London, W. C. 2, England.
French Patent	French Patent. L'Imprimerie nationale, Rue Vielle-du-Temple, 87, Paris 3, France.
German Patent	German Patent. Der Reichsdruckerei, Berlin, Germany.
Harper's Weekly	Harper's Weekly (merged into The Independent). 119 West 40th street, New York, N. Y.
Ind. chim.	L'Industrie chimique, Revue universelle des produits chimique et des industries annexes. H. Mounier, 32, Rue le Peletier, Paris (IXe), France.
Independent	Independent, The. 119 West 40th street, New York, N. Y.
Indian Engineer	Indian Engineer (now Indian and Eastern Engineer). Calcutta, India.
Indian Engineering	Indian Engineering, Calcutta, India.
Indian Forest Records	Indian Forest Records. Dr. E. N. Munns, U. S. Forest Service, San Francisco, Cal.
Indian Forester	Indian Forester, The. Calcutta, India.
Indian Pharmacologist	Indian Pharmacologist. Calcutta, India.
Indian Planters' Gazette	Indian Planters' Gazette and Sporting News. Calcutta, India.
Indian Textile J.	Indian Textile Journal. Bombay, India.
L'Industria della carta	L'Industria della carta e della arti grafiche. Corso Principe Umberto 34, Milano, Italy.
Intern. Rev. Sci. Pract. Agr.	International Review of Science and Practice of Agriculture. International Institute of Agriculture, Rome, Italy.

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Intern. Sugar J.	International Sugar Journal, The. 2, St. Dunstan's Hill, London, E. C., England.
J. agr. trop.	Journal d'agriculture tropicale. Paris, France.
J. Am. Chem. Soc.	Journal of the American Chemical Society. Charles L. Parsons, Box 505, Washington, D. C.
J. Am. Peat Soc.	Journal of the American Peat Society. American Peat Society, Toledo, Ohio.
J. Chem. Met. Soc. S. Africa	Journal of the Chemical, Metallurgical and Mining Society of South Africa. Fred Rowland, Sec'y., Old Municipal Bldgs., De Villiers street, Johannesburg, South Africa.
J. fabr. sucre	Journal des fabricants de sucre. Georges Dureau, 160 Boulevard de Magenta, Paris, France.
J. Forestry	Journal of Forestry. Society of American Foresters, Washington, D. C.
J. offic. Afrique Occid. Franc.	Journal officiel de l'Afrique Occidentale Française. Dakar (?), French West Africa.
J. Roy. Soc. Arts	Journal of the Royal Society of Arts. G. Bell and Sons, Ltd., York House, Portugal street, London, W. C., England.
J. Soc. Chem. Ind.	Journal of the Society of Chemical Industry. Charles G. Cresswell, Broadway Chambers, Westminster, London, S. W., England.
J. Soc. Dyers Colourists	Journal of the Society of Dyers and Colourists. Pearl Assurance Bldgs., Market street, Bradford, England.
Japanese Patent	Japanese Patent. Patent and Trade Mark Office, Department of Agriculture and Commerce, Tokio, Japan.
Manufacturers Record	Manufacturers Record. Manufacturers Record Publishing Company, corner Commerce and Water streets, Baltimore, Md.
Mitt. kgl. mech.-tech. Versuchs.	Mitteilungen aus den königlichen mechanisch-technischen Versuchsanstalten. Julius Springer, 23-24 Link-Strasse, Berlin W. 9, Germany.

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Mitt. kgl. tech. Gew.-Mus. Wien	Mittheilungen des kaiserlichen königlichen technologischen Gewerbe-Museums in Wien. Vienna, Austria.
Mitt. Lab. Wiener Handelsakademie	Mitteilungen aus dem Laboratorium der Wiener Handelsakademie, Vienna, Austria.
Mon. produits chim.	Moniteur des produits chimiques. Paris, France.
Mon. sci.	Moniteur scientifique du Docteur Quesneville. Rue de Buci, 12 (Faubourg Saint-Germain), Paris, France.
Moniteur	Moniteur de la papeterie française, Le. Paris, France.
Monthly Consular and Trade Reports	Monthly Consular and Trade Reports. Superintendent of Documents. Washington, D. C.
La Nuova Agricultura del Lazio	La Nuova Agricultura del Lazio. Rome, Italy.
Oesterr. Chem.-Ztg.	Oesterreichische Chemiker-Zeitung Pestalozzigasse 6, Vienna, I, Austria
Paper	Paper, Inc., 251 West 19th street, New York, N. Y.
Paper Ind.	Paper Industry, The. Edward B Fritz, 356 Monadnock Block, Chicago, Ill.
Paper Maker	Paper Maker and British Paper Trade Journal, 47 Cannon street. London, E. C. 4, England.
Paper Makers' Mo. J.	Paper Makers' Monthly Journal, The. Marchant Singer and Company, 47 St. Mary avenue, London, E. C., England.
Paper Making	Paper Making. 5, Ludgate Circus Bldgs., London, E. C., England.
Paper Mill	Paper Mill and Wood Pulp News, The. L. D. Post, P. O. Box 592. New York, N. Y.
Paper Trade J.	Paper Trade Journal. Lockwood Trade Journal Co., 10 E. 39th street, New York, N. Y.
Paper Trade Rev.	Paper Trade Review. Edinburgh, Scotland.
Papeterie	Papeterie, La. L'Homme & Argy., Rue Lagrange 9, Paris, France.
Papier	Papier, Le. 339 Rue de Clérac-a-Sillac, Angoulême (16 Rue de Rocket), Paris (8e), France.

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Papierfabr.	Papier-Fabrikant. Otto Elsner, Oranienstrasse 140-142, Berlin S. 42, Germany.
Papier-Ztg.	Papier-Zeitung. Papierhaus, Dessauer Strasse 2, Berlin S. W. 11, Germany.
Philipp. J. Sci.	Philippine Journal of Science, The. Library, Bureau of Science, Manila, Philippine Islands.
Prakt. Handbuch Papierfabr.	Praktisches Handbuch der Papierfabrikation. Papier-Zeitung, Papierhaus, Dessauer Strasse 2, Berlin S. W. 11, Germany.
Proc. Roy. Soc. Victoria	Proceedings of the Royal Society of Victoria, Melbourne, Australia.
Prog. agr. vit.	Progres agricole et viticole. Rue Albisson 1 (Rue National, Maison Batigne), Montpellier, France.
Publishers' Weekly	Publishers' Weekly, 62 West 45th street, New York, N. Y.
Pulp Paper Mag. Can.	Pulp and Paper Magazine of Canada. Industrial and Educational Publishing Co., Gardenvale, P. Q., Canada.
Queensland Agr. J.	Queensland Agricultural Journal, The. Brisbane, Australia.
Répert. pharm.	Répertoire de pharmacie. C. Crinon, 20, Boulevard Richard-Lenoir, Paris, 11e, France.
Rev. ind. agr. Tucumán	Revista industrial y agricola de Tucumán. Dirección Estación Experimental Agricola, Las Talitos, Casilla Correo 71, Tucumán, Argentine Republic.
Rev. papeterie	Revue de la papeterie française et étrangère. Paris, France.
Rhodesian Agr. J.	Rhodesian Agricultural Journal, The. Salisbury, Rhodesia.
S. African J. Ind.	South African Journal of Industries, Pretoria, South Africa.
S. Am. J.	South American Journal. London, England.
Sci. Am.	Scientific American. Scientific American Publishing Company, Munn and Company, 233 Broadway, New York, N. Y.

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Sci. Am. Suppl.	Scientific American Supplement. Scientific American Publishing Company, Munn and Company, 233 Broadway, New York, N. Y.
Science Industry	Science and Industry. Commonwealth Institute of Science and Industry, Danks' Bldg., Bourke street, Melbourne, Australia.
Scottish Rev.	Scottish Review. Paisley, Scotland, also London, England.
Special Consular Reports	Special Consular Reports. Foreign and Domestic Commerce Bureau, Washington, D. C.
Sugar	Sugar. Beet Sugar Gazette Company, Hearst Bldg., Chicago, Ill.
Svensk Pappers-Tidning	Svensk Pappers-Tidning. Svenska Pappersbruksföreningen, Hovslagaregaton 3, Stockholm, Sweden.
Tech Eng. News	Tech Engineering News, The. Massachusetts Institute of Technology, Cambridge, Mass.
Tech. World Mag.	Technical World Magazine (now Illustrated World). Chicago, Ill.
Technics	Technics, London, England. (Only vols. 1-4 published.)
Tidskrift papirindustri	Tidskrift for papirindustri. Prinsens Gate 22, Kristiania, Norway.
Tropenpflanzer	Tropenpflanzer, Der. Berlin, Germany.
Tropical Agriculturist	Tropical Agriculturist. Colombo, Ceylon.
U. S. Patent	United States Patent. Commissioner of Patents, Washington, D. C.
Van Norden Mag.	Van Norden Magazine. New York, N. Y.
Wellcome Trop. Research Lab., Khartoum	Wellcome Tropical Research Laboratory, Khartoum, Sudan.
Wochbl. Papierfabr.	Wochenblatt für Papierfabrikation. Güntter-Staib, Biberacha. d. Riss, Württemberg, Germany.
Wochenschr., niederösterr. Gewerbe-Vereins	Wochenschrift des niederösterreichischen Gewerbe-Vereins. Vienna, Austria.
Wochenschr. Papier Schreibwaren Handel	Wochenschrift für den Papier- und Schreibwaren-Handel und die Papier verarbeitende Industrie. Potsdam, Germany.

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World Today	World Today (now Hearst's Magazine), 119 West 40th street, New York, N. Y.
World's Paper Trade Rev.	World's Paper Trade Review, The. W. John Stonehill, London, England.
World's Work	World's Work, The. 116 West 32d street, New York, N. Y.
Z. angew. Chem.	Zeitschrift für angewandte Chemie. Otto Spamer, Leipzig, Germany.
Zentr. oesterr-ungar Papierind.	Zentralblatt für die oesterr-ungar Papierindustrie, I, Schwangasse (ecke Kärntnerstrasse, 26), Vienna, Austria.

THE END.

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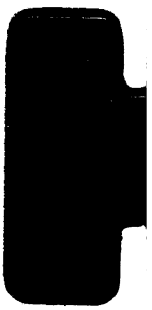

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